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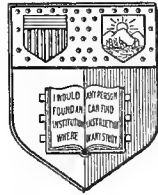
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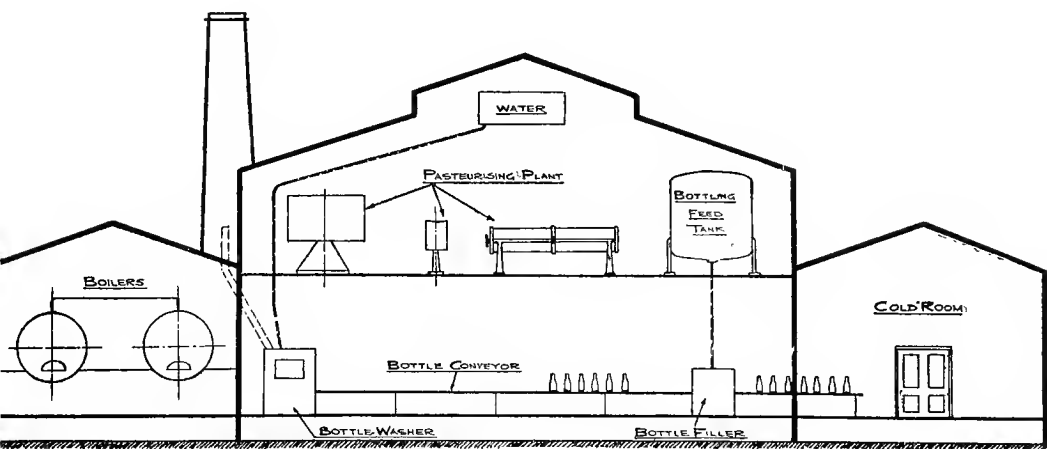
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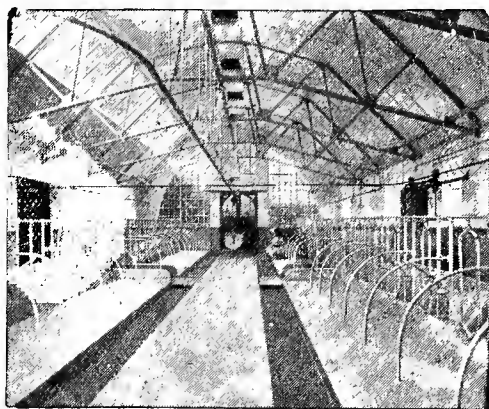
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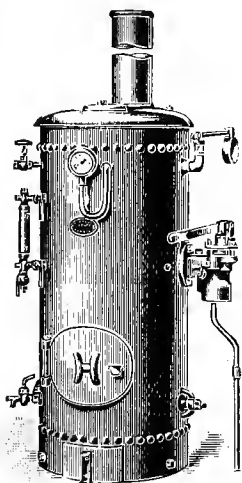
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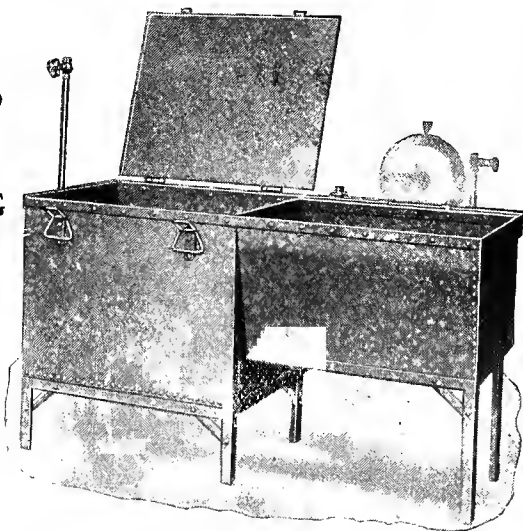
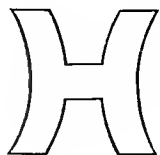
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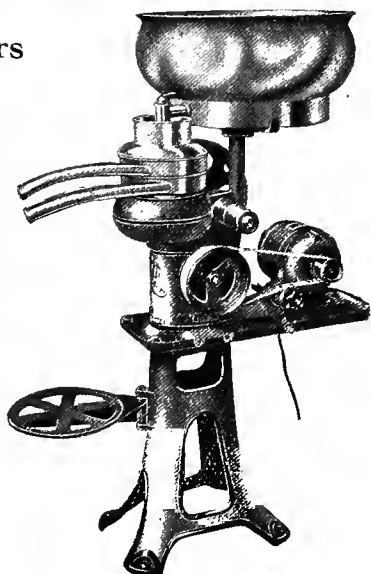
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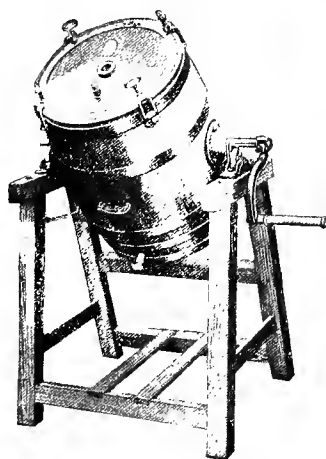
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THE NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING.

ITS ORIGIN, GROWTH AND FUNCTIONS.

The Origin of Organised Research in the Dairying Industry.

The Dairying Industry occupies a very important position in this country, not only from the point of view of those who are engaged in it, but also from that of the public generally, who depend upon it for some of their most important and vital foodstuffs. The industry renders, therefore, an essential national service, and its welfare and efficiency are the concern of all of us. That it shall be run economically and that its products shall be of the highest possible standard are matters in which we are all interested to a greater or lesser degree. They affect the national pocket and the national health. But "economy" and "standard" are not absolute terms; their interpretation is governed by our knowledge of what is possible, and that knowledge is continually growing. What is responsible for this continued growth of knowledge, and why has that growth been accelerated in recent years? The farmer has very much more knowledge of the properties of the foodstuffs which he feeds to his cattle than he had, say, twenty years ago. There is very much more knowledge available for him on the effect of these foodstuffs on the milk production, and on the health of his animals. More knowledge is available on the science of breeding cattle for milk production; and the best methods of handling and carriage of milk. The consumer on his part can obtain fuller knowledge of the food value of milk and its products, of how to avoid dirty milk and milk which may be the carrier of disease.

The farmer has probably got his information on many of these points from the agricultural organiser of his county, or in response to inquiries to the agricultural press. The members of the public are kept informed through the general press, and by the medical officers of health for their respective local authorities. But all this knowledge did not originate with these agencies. They disseminate it, but it finds its origin in research and experiment. Someone has got to test and try materials and methods, to investigate causes and effects, in order that new knowledge may be obtained. Now it is not enough that research and experiment in the dairying industry should be left to chance. To be effective it must be organised and it is desirable that it shall be concentrated; that a picked body of workers shall devote their whole energies to the problems of the industry, and to the revelation of new knowledge, and that the results of their efforts shall be at the disposal of all who will avail themselves of them.

Before the year 1909, research into the problems of the agricultural industry had not been organised on a national scale, though continuous research had been to some extent recognised by the State. In the main, however, we were content to rely on the results of foreign research, with the result that we were invariably behind other countries in the practical application of new knowledge and new discoveries in agriculture. Further, there were problems peculiar to the agricultural conditions of our own country, to which the results of foreign research offered no solution. The need for the study of these problems was urgent, but for their investigation neither organisation nor funds were available.

ITS ORIGIN, GROWTH AND FUNCTIONS—continued.

The recognition of the necessity for national action in this matter was given practical effect when the Development and Road Improvement Fund Act was passed in 1909. Sir Daniel Hall, who was one of the first commissioners appointed under the Act, has stated (in an article in the *Industrial Year Book* for 1922) "The Development Commissioners in their Act, were expressly charged with the promotion of research, and forthwith proceeded to formulate a scheme upon the lines of which work now proceeds. The principle at the base of their scheme was the division of the field of research up by subjects and the establishment at various centres, as a rule in conjunction with a University, of Institutes, each charged with the fundamental research dealing with one particular branch of the subject. Three main reasons weighed with the Commissioners in adopting this form of organisation :

1. Research was thereby removed from immediate state control.
2. Concentration of effort was ensured, and overlapping duplication avoided.
3. Each Institute could work out a continuing scheme of research and deal with the subject as a whole.

The objects of the Commissioners were, therefore, to create an organisation through which the work of research into the problems of agriculture could be directed and co-ordinated, and at the same time to secure for that organisation freedom of development in order that it might respond to the needs of the industry as they revealed themselves. To achieve these objects the familiar method of the "grant-in-aid" was adopted. The Institutes established by the Commissioners were not intended to be State institutions—they were as a rule established in conjunction with universities which were responsible for their administration and which received through the Ministry of Agriculture, grants-in-aid of their expenditure made after approval by the Ministry of financial estimates and programmes of work which had to be submitted annually. They, therefore, enjoyed the measure of freedom which is accorded to universities in this country, and like the universities, they depended for their full development and progress on the support of those interested in their work. As their work developed, it was anticipated that financial support in increasing measure would be given from other than State sources, and in particular by the members of the industry for whose benefit the Institutes has been established.

THE ESTABLISHMENT OF THE NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING.

It has been indicated in the foregoing pages that the principle at the base of the scheme of agricultural research formulated by the Development Commissioners was the establishment of research institutes each charged with the fundamental research dealing with one particular branch of the subject. Reading, which is in the midst of a dairying district, and which possessed a flourishing University College (now the University of Reading) was chosen as the centre at which research into the problems of dairying should be concentrated. In 1912 the Research Institute in Dairying was accordingly established at University College, Reading.

In the matter of numbers of personnel and equipment the Institute was a very modest affair. The first members of its Staff were a Bacteriologist, a Chemist, and one Laboratory Assistant. Its laboratories were improvised from rooms on the top floor of a dwelling house in Reading, and it had no farm and no dairy. Its income in the first year was £1,610, of which £1,510 was a grant from the Development Fund through the Ministry (then Board) of Agriculture, the remainder being provided by University College, Reading.

ITS ORIGIN, GROWTH AND FUNCTIONS—continued.

It was realised at the time and has been demonstrated since that this provision was quite inadequate for the work involved. It must be remembered, however, that although practically all the income of the Institute did, in fact, come from the Development Fund, the grant made by the Commissioners was in theory a grant *in aid* of the work, and it was anticipated that additional income would ultimately be found from other sources, and in particular by those for whose benefit the Institute had been established.

Further, no detailed knowledge was available in the first instance as to the nature and extent of all the difficulties awaiting solution, and one of the first duties of the new institute was to explore the ground, and as time went on, to train a staff of the right type for the work which was to be done. The Institute was handicapped by the fact that no statistical evidence was available concerning the amount and causes of loss in milk and dairy industries, though it was known that losses were occurring.

Early Investigations. In its early days the Institute was not in a position to acquire adequate information concerning these losses, but one of the first problems undertaken, namely, the causes of discolouration of Stilton Cheese, indicated the need for an investigation of the methods of production of milk, and their effect on keeping quality and cleanliness, etc.

The need for such an investigation was confirmed later as a result of inquiries by a Committee appointed in 1916 (of which Dr. Ernest Mathews, C.V.O., was Chairman) to assist the work of the Institute. These inquiries revealed the fact that grave losses, amounting to not less than half a million pounds (pre-war values) in London alone were being incurred by the milk and dairy industries, largely through bad methods of production and distribution.

But if the work of that committee revealed the magnitude of the problem which confronted the Institute, it also emphasised the inadequacy of the facilities available for their investigation.

When one speaks of the need for an investigation of the problems of the handling and distribution of milk, one is using a comprehensive phrase which covers a number of specific problems, for the solution of which it was essential that the Institute should possess a farm on which animals could be bred and fed experimentally, and methods of management tried out, and a dairy where milk and its products could be controlled and studied. More adequate laboratories were also a necessity. Moreover, as has already been indicated, in its origin the Institute was one of a number of institutes each devoted to a specified branch of agricultural research. At the same time it was intended that each institute should deal with its subject as a whole and, while it is true that dairying is one branch of agriculture, it is also true that the agricultural aspect is only one aspect of dairying. From the point of view of the public generally, the Public Health aspect is at least equally important. Milk is an essential foodstuff, particularly for young children. It is also a potential carrier of disease. How can we secure that our milk supply shall reach the consumer with its food value unimpaired, and free from harmful bacteria? The answer to this question must be sought for on the farm, in the cowshed, and in the dairy, as well as in the laboratory.

ITS ORIGIN, GROWTH AND FUNCTIONS,—continued.

By 1916 the work which had already been done, and the fact that information had been collected which gave some conception of the magnitude of the problems which still awaited solution, justified a widespread appeal for funds to secure new laboratories and a farm and dairy. Progress with this scheme was delayed by the war, but by 1920 a suitable farm had been found in the Shinfield Manor Estate, which included a house capable of conversion into laboratories. Proposals for the purchase of the farm were made to the Ministry of Agriculture, which body obtained from the Development Commissioners the promise of a grant on the pound for pound basis towards the purchase price and the cost of stocking the farm, and an appeal for funds to meet the balance expenditure was immediately issued.

By October 1920 the Institute was in possession of its new farm, although the actual purchase was not completed until the following June.

The Institute was, however, still faced with the need for additional farm buildings designed to meet its particular needs, for an experimental dairy, for laboratory accommodation, and for engineering plant to provide water, power, light, etc. Proposals were accordingly made to the Ministry of Agriculture for the adaptation of the existing Manor House for the purpose of laboratories, for the erection of suitable farm buildings and a dairy, and for the provision of engineering plant and general equipment, and the promise of a further grant in aid, on the pound for pound basis, was obtained by the Ministry from the Development Commissioners.

Removal to Shinfield. The erection of the new buildings, etc., was begun in 1922, and the staff entered into full possession of the new Institute in October 1923.

On July 19th, 1924 the Institute was formally opened by the Viscount and Viscountess Elveden (now the Earl and Countess of Iveagh). The words used by Lady Iveagh on that occasion are worthy of record. "This key," she said, "is going to open the National Institute for Research in Dairying, and in doing that I firmly believe that it will confer, on generations yet unborn, some of the enormous benefits which science holds hidden for humanity, and which patience and endeavour on our part will eventually reveal."

The Government and Constitution of the Institute.

From its foundation in 1912, the Institute was under the direct control of University College, Reading, and formed a department of the Faculty of Agriculture and Horticulture of that College. In 1921, however, when the purchase of the Shinfield Manor Estate for the purposes of the Institute was completed, it was considered desirable to grant to the Institute a measure of autonomy and the Council of the College executed a Deed of Trust in relation to the property and funds of the Institute. By the terms of this Deed, all such property and funds, present and future, are held in trust for the use of the Institute, and all general powers of management and control of the Institute are delegated to a Board, of which the Earl of Iveagh is Chairman, and on which are represented :—

The Ministry of Agriculture and Fisheries.

The Ministry of Health.

The Council of the University of Reading.

The Royal Agricultural Society of England

ITS ORIGIN GROWTH AND FUNCTIONS—continued.

The British Dairy Farmers' Association.

The National Farmers' Union.

The Subscribers to the Trust Funds of the Institute.

Persons engaged or interested in the industries or problems concerned with milk or milk products.

The work of the Institute is organised in three main departments:—Dairy Husbandry, Chemistry and Bacteriology, each under the direction of a responsible Head. Co-ordination of the work within the Institute is secured through the agency of a Professional (Staff) Committee, consisting of the Heads of the Departments of the Institute and certain members of the Faculty of Agriculture of the University of Reading.

It has been found that many of those who have benefited by the work of the Institute are prepared to indicate their continued interest in the work by making an annual subscription to the funds of the Institute. A membership scheme has therefore been established whereby those who wish to keep in touch with and to assist in the work may become Fellows (minimum subscription £5 5 0), or Members (minimum subscription £1 1 0), of the Institute.

Description of the Institute.

Shinfield Manor House, the home of the Institute, is about four miles south of Reading railway stations, in the Parish of Shinfield, and is a typical example of the old English country house, with its immediate surroundings of pleasant gardens and green lawns, and more distant view of woods and pastures. As far as possible, all the amenities of the place have been preserved. The house itself has been adapted for use as laboratories, library and offices, without structural alteration. The ground floor comprises Entrance Hall, the Library, Administrative Offices and Chemical Department. The latter includes two large laboratories, the private room of the head of the department, Kjeldahl room and Balance room. The old kitchens and domestic offices, which are also on the ground floor, have been adapted for use as a media making department and stores.

On the first floor are to be found the Bacteriology and Dairy Husbandry Departments. The Bacteriology Department includes four laboratories, incubator room and a room for the head of the department, and a corridor which is used to accommodate incubators.

The Dairy Husbandry Department includes one large and one small office, with a private room for the head of the department, and a landing used for the display of charts illustrating the work of the department.

Of the attic rooms, one has been fitted up as a dark room, and the remainder are used as stores.

The old stables and coach houses present externally practically the same appearance as when used for their original purpose, though the chimney shaft which now rises from their midst gives an indication of the fact that they now contain the plant which provides the Institute with heat, light, power, steam and water. This range of buildings, which forms one side of the courtyard at the rear of the Manor House, includes boiler house, engine rooms, pumping room, and engineer's shop.

Other outbuildings, which complete the four sides of the courtyard, include a barn in which are conducted experiments on the drying of whey and milk. Tests of the efficiency of dairy equipment and appliances are also conducted in this barn as well as in the dairy.

The Dairy.

The experimental dairy of the Institute is one of the new buildings erected when the Institute took possession of the estate. It includes rooms for:—

1. Receiving and cooling of milk.
2. Washing and sterilising of utensils.
3. Separating and butter making.
4. Cold room.
5. Hard cheese room.
6. Stilton making room.
7. Stilton coating room.
8. Room at present used for experimental pasteuriser of Chemical Department.
9. Cellars for cheese ripening.

DESCRIPTION OF THE INSTITUTE—continued.

The work of the dairy in the manufacture of butter and cheese is mainly done in conjunction with the Bacteriology and Chemistry Departments.

The Farm.

The Institute owns a farm of 350 acres, of which 155 acres are arable, 145 acres grass, and the remainder are occupied by woods, gardens, allotments, buildings, etc.

The main farm homestead is at Church Farm, Shinfield, closely adjacent to the Institute. When purchased in 1920, the existing buildings consisted of a stable and barns, yards, and a small cowshed in a bad state of repair, additional buildings were erected in 1923. Some of the old buildings are now in urgent need of replacement, but nevertheless the possession and use of a badly constructed cowshed with a thatched roof have provided the Staff of the Institute with opportunities for the study of milk production and handling under extremely primitive conditions. The experience gained in this work has been invaluable, and has enabled the Staff to understand the difficulties which confront the farmer in improving and making the best of the conditions which exist on the farm he occupies. Further, the possession of the old buildings has made it evident to many visitors that in the early stages of its work on the production of clean milk, the Institute had no advantages such as are conferred by the possession of convenient, easily-cleaned, and well lighted buildings, and that the advice given to farmers is based on experience and research work carried out under very ordinary farm conditions.

The new buildings comprise a food store range of two stories, a silo, yards and stall accommodation for fully thirty cows, with bull boxes, calf pens, and a separate milking shed for twenty cows. These buildings enabled a considerable and much needed extension of the work of the Institute to be undertaken, and they have proved in most respects very suitable for their several purposes. In addition, many farmers and architects considering the erection of new and the adaptation of old buildings have visited the farm in order to study the general arrangement and internal construction and fittings.

It is intended that the Institute shall for many years to come maintain and use some old buildings which have been converted and improved to meet modern requirements, and that, so far as possible, new designs in internal equipment shall be incorporated in the new buildings. In this way, therefore, it is hoped that a visit to the Institute farm may be instructive in respect of dairy farm equipment, as well as in respect of the research and experimental work.

In the management of the farm the main objects in view are the maintenance of a herd of cows for the study, in the course of time, of all aspects of dairy herd management, and for the production of milk under controlled and known conditions for research work and for sale, and the provision of facilities for investigations in the growth and use of dairy farm crops.

The Work of the Institute.

It will be realised from what has already been said that the functions of the Institute are wide, and that the full extent of the problems with which it has to deal will only be realised gradually as the work progresses.

In the following pages a brief account will be given of some of the work at present being undertaken at the Institute, and an attempt will be made to indicate some of the directions in which the necessity for further work has been revealed.

DAIRY HUSBANDRY DEPARTMENT.

The Dairy Herd and Its Improvement.

The herd now consists of some 90 head of all ages, mainly Dairy Shorthorns but with ten to twelve Guernseys. The Guernseys are all fully pedigreed stock; some years ago the English Guernsey Cattle Society presented to the Institute six in-calf heifers and this generous gift formed the basis of the Guernsey section of the herd.

The animals of this breed do well and six of the cows now in the herd have qualified for entry into the Advanced Registry of the English Guernsey Cattle Society on the basis of their yields of milk and butter fat. In the future no cow will be retained in the herd for breeding purposes which does not so qualify.

The main work of herd improvement has been carried out with the Dairy Shorthorns and as the Institute did not at the outset possess adequate accommodation for milking cows, nor was it in a position to pay high prices for stock, the basis of the herd consisted of heifers, yearlings and calves, purchased in the district and some surplus stock from the herd of Dairy Shorthorns maintained at the farm of the University of Reading.

The first interesting point is the contrast between the milking qualities obtained from the above sources. The heifers and calves bought in the district were of no special quality because at that time—1920 and 1921—any young stock from cows with really good milk records made extraordinarily high prices, hence those purchased were typical of the class of stock which might be bought by any farmer who desired to start to replenish a herd without paying unduly high prices. On the other hand the stock purchased by valuation from the University farm were all out of selected milk recorded cows and by bulls of good milking ancestry. Of the former, and in all, some forty heifers and calves were purchased, only about ten proved satisfactory milkers when brought into the dairy herd, whereas of some twelve heifers purchased from the University herd, all have proved satisfactory except one. In the choice of animals, therefore, for the commencement or increase of a dairy herd, the wisest policy—funds permitting—is to select only those from cows which have good milk records to their credit and are the progeny of a well bred bull of similar dairy breeding. The reason for the policy followed by the Institute in 1920-21 was the inflated prices then ruling for recorded stock; this reason does not now hold good and the differences in market value between the progeny of good recorded stock and unrecorded nondescript animals is more than balanced by the better quality and breeding of the former.

DAIRY HUSBANDRY DEPARTMENT.—continued.

When a herd has been gathered together it may be maintained by buying or breeding. To keep up a herd to a high standard by buying requires specially good judgement, and involves much greater risk of introducing contagious diseases; a large output of milk per head may be attained but there is little or no chance of improving the herd from year to year. The maintenance of a herd by breeding gives a much greater freedom from disease and as a rule a much higher standard of health is reached; the breeding of all heifers introduced is known and by making use of the valuable information obtainable by milk recording, butter fat testing and calf marking, a high output may be attained; at the same time the type and uniformity of the herd can be improved, and in those breeds where the herd book is still "open" a herd can be steadily graded up to pedigree standard.

The policy with regard to the Dairy Shorthorn section of the Institute's herd was to grade up from the basis already described to pedigree standard through the register of the Dairy Shorthorn Association, and at the same time increase the milk yield, improve the type and maintain a herd uniformly healthy and free from tuberculosis. This policy could only be pursued by maintaining the herd by breeding, and although this meant a slow increase in numbers during the early years, the lack of adequate buildings prevented this from being a serious hardship. Since 1922 therefore, no female animals have been purchased with the exception of three heifers from the University farm in 1923 and four in 1924, and considerable progress has been made towards the attainment of the aims decided on when the Institute purchased a farm in 1920.

With regard to grading up to pedigree standard, progress was facilitated by the fact that all the animals purchased from the University farm were already entered in the Dairy Shorthorn Association's Register, and at the present time all the herd comprises 24 animals of various ages entered in Coates's Herd Book, 40 entered in the four classes of the Dairy Shorthorn Association's Grading Register, and 8 which have not yet qualified. The basis of entry in Class A of the Grading Register is that a cow must be passed by inspection as being of satisfactory Shorthorn type, must yield 8000 lb. milk in one year or an average of 6500 lb. in two successive years, and be in calf to a pedigree Shorthorn bull; pedigree bulls must be used for four generations in all and then the female progeny are eligible for entry into Coates's Herd Book as pedigree stock. This system of raising a herd from ordinary commercial Shorthorn cows to pedigree standard by the use of successive pedigree bulls affords a ladder of progress to the practical dairy farmer, and breeds which maintain an "open" herd book in this manner have certainly an advantage over those in which the herd book is "closed," i.e., only animals can be entered which are from pedigreed parents. The progress which has been made towards a completely pedigree herd bred from cows of good type and milking qualities, by the Institute herd, and to a still greater extent by the herd at the University Farm already referred to, can be equalled by any practical dairy farmer, and at the same time the average market value of the stock is increased in the event of a sale.

Another main item in the management of the herd has been to improve the milk yield, but as the herd has been increasing in size year by year and a large proportion of the young stock bought in the early stages did not develop into satisfactory milkers, definite progress has only been attained within the last and the present years. The herd averages as stated by the Berkshire Milk Recording Society for the last six years have been as follows.

DAIRY HUSBANDRY DEPARTMENT.—continued.

Year.		Average Yield per Cow.		No. of full year cows.
1921-22	....	6856	....	8
1922-23	....	5148	....	12
1923-24	....	6949	....	17
1924-25	....	6792	....	25
1925-26	....	6941	....	25
1926-27	....	8364	....	28

The average for 1927-28 promises to be quite up to that of last year.

The results of milk recording have been used carefully in eliminating the poorer milkers. If a heifer which calves in a normal manner and at $2\frac{1}{2}$ to $2\frac{3}{4}$ years does not give at least $2\frac{1}{2}$ gallons daily soon after calving, she is fattened out as quickly as possible; also, although starting well, if the yield in the first lactation period of 40 to 44 weeks does not exceed 5,500 lbs. such an animal is as a rule sold at the time of calving her second calf. No age limit is fixed after which cows must be sold. A cow is retained in the herd as long as she milks well, breeds regularly and is sound in her udder and in general health.

The reason for the comparatively low average in the early years has been stated and the better yields obtained since 1925 are due to the inclusion in the herd of home-bred stock of good milking qualities.

The breeding of good dairy stock leads directly to a consideration of the choice of stock bulls. The bulls used in the Institute herd have been selected from pedigree Dairy Shorthorn herds and the main points considered in the choice have been the milk records of the dam and grand-dams; the possession by them of shapely udders and teats; the conformation of the bull himself; and also the bull and his parents must have passed the tuberculin tests. The statement that "the bull is half the herd" is a common-place amongst dairy farmers, but many who are breeding their own stock to maintain their herd give little more attention to the choice of a bull than to the selection of one cow—they may believe in the above adage, but their belief is not exemplified by their actions. At the same time, not all those who take great care in the choice of a bull are able to bring about the improvement they desire, because, in the absence of sufficient knowledge of the principles of inheritance of dairy qualities, there is still an element of luck associated with successful breeding. Up to the present the bulls used at the Institute farm whose progeny have come into milk have proved their merit in the most effectual manner—namely, their daughters are proving on the whole better milkers than their dams were at the same age. Nine daughters of the first bull purchased averaged 7,123 lb., milk after their first calf and four daughters of the second bull are also promising well in their first lactation period.

This latter bull has been retained in the herd until his heifers have come into milk, in contrast to the common practice of selling a bull for slaughter after about three years use, and now that his progeny are promising milkers, of good type and with excellent udders, this bull, though now five years old, will be retained as long as he is useful.

DAIRY HUSBANDRY DEPARTMENT.—continued.

The experience of breeds of all classes of stock is that *the use of a sire which has proved his value by the quality of stock*, is the surest way of breeding the type of animal desired, and although in milk production bulls must be kept until four to five years old before their merit can be judged by this standard, there is no doubt that greater efforts should be made by many dairy farmers to keep good bulls, which have thrown promising heifers, until the oldest of the latter come into milk. Many good dairy bulls have been prematurely slaughtered.

The herd has also an excellent record for healthiness. No cases of contagious abortion have occurred, and the tuberculin tests required for herds producing Grade A (Tuberculin Tested) milk have been applied twice yearly since 1923. The proportion of reactors was always small and since the spring of 1925 only one reactor has been found in five successive tests of all the in-calf cows and heifers in milk. Our experience confirms that of many other farmers that the standard of healthiness is in every respect higher in a tubercle free herd than in untested herds maintained under similar conditions.

Experimental Work on the Farm.

The Growing of Lucerne.

The importance of lucerne as a crop on the dairy farm is becoming more generally recognised. It may be utilised for hay, soiling purposes or for silage, and is not likely to suffer from drought in dry seasons; also at the same time it improves the fertility of the soil on which it grows. The chief difficulties in the growing of lucerne successfully are those of obtaining a satisfactory plant and combating weed competition during the first year's growth. The first-mentioned difficulty has been to a large extent overcome by the treatment of lucerne seed with cultures of the micro-organism which enables the lucerne plant to make use of the nitrogen of the air. The second difficulty may be partly overcome by thorough cleaning of the land before sowing, and by surface cultivation afterwards. In order to obtain information on the latter point an experiment was commenced in 1924 and consultation with and by means of financial assistance from the Research Committee of the Royal Agricultural Society of England, and brought to a conclusion in the autumn of 1926.

Six plots of one-tenth acre each, in quadruplicate, were sown with Provence lucerne seed at the rate of 24 lb. per acre in June 1924, and the experimental treatment was as follows: Series (a) seed broadcast and covered and no further surface cultivation; series (b) and (c) seed broadcast and covered, and harrowed several weeks after sowing and at suitable intervals afterwards; (d) seed drilled and covered and no further surface cultivation; (e) seed drilled and covered, hand hoed several weeks after sowing and at suitable intervals afterwards; (f) seed drilled and covered, and harrowed several weeks after sowing and at suitable intervals afterwards.

After four weeks' growth it was found that the tap-root of the lucerne seedlings had penetrated at least eight inches into the soil. It was intended to commence surface cultivation five to six weeks after sowing, but wet weather conditions delayed the operations more than a month, and before harrowing could be commenced it was necessary to mow the growth of lucerne and weeds which had covered the ground.

DAIRY HUSBANDRY DEPARTMENT.—continued.

After the lucerne and weeds were removed, the harrowing and hoeing were carried out according to the above scheme.

The plots in which the seed was drilled showed more vigorous and regular growth throughout, and the hand-hoed plots were more productive than those which were harrowed only; the plots receiving no surface cultivation showed a sparse and weakly plant.

The produce of the plots was cut and made into hay as far as weather conditions would allow and the results for 1926, which are concisely tabulated below, give an indication of the effect of the treatment on the lucerne plants two years after sowing.

**Summary of Hay produced by various Series of Lucerne Plots
during the year 1926.**

	First Cutting Yield per acre.		Second Cutting Yield per acre.		Third Cutting Yield per acre.		Total weight of Crop for year. Yield per acre.		
	cwt.	lb.	cwt.	lb.	cwt.	lb.	tons.	cwt.	lb.
Series (a) Seed Broadcast —no treatment	*14	102	22	61	9	62	2	7	1
Series (b) and (c) Seed broadcast—harrowed....	11	42	24	64	10	75	2	6	69
Series (d) Seed drilled— no treatment	20	22	25	60	10	45	2	16	15
Series (e) Seed drilled— hand hoed	30	28	36	73	13	64	4	0	53
Series (f). Seed drilled— harrowed	18	64	31	33	11	33	3	1	18

*The first cutting in 1926 from this plot contained a considerable proportion of weeds.

Silage Crop Mixtures and Wastage in the Silo. Since the erection of a silo in 1924 various mixtures of silage crops have been grown with a view to finding a mixture which will give a good yield per acre and at the same time remain erect up to the time of mowing. The mixtures at first tried consisted of 33½ per cent winter vetches by measure and the remainder usually winter oats, or oats, wheat, rye and beans.

Three years' experience showed that the above seeding of vetches was unnecessarily heavy and that their rank growth gave a laid crop, whatever mixture of cereals and beans was sown with the object of keeping the crop erect. Last year the proportion of vetches was reduced to 25 per cent by measure, the seeding being one bushel vetches, one bushel beans, one and a half bushel winter oats and half a bushel cone wheat on four acres, and one bushel vetches and two and a half bushels winter oats and half a bushel cone wheat on six acres. Both mixtures

DAIRY HUSBANDRY DEPARTMENT.—continued.

proved quite satisfactory and stood well at the time of cutting—June 14th to 20th. The total crop on the ten acres was weighed load by load when carted from the field and showed a yield per acre of 9.8 tons.

During each of the three years the silo has been in use a record has been kept of the weight of green material blown in and the weight of good silage taken out. In 1924-25 112 tons of green material were put in and 92½ tons of silage were taken out, showing a loss of 19½ tons or 17.4 per cent. Of this loss 1 ton 7 cwt. were accounted for by the fact that the silage from the top of the silo was unfit for food, and it is also known that the record of the amount of silage taken out was incomplete. In 1925-26 120½ tons of green material were put in; at the end of the winter season 10 tons of silage remained in the silo, as estimated by taking a core to the bottom, and 96 tons of silage were used, thus accounting for 106 tons and therefore showing a wastage of 14½ tons or 12.1 per cent, of which two tons consisted of material at the top unfit for food. In 1926-27 125 tons 7 cwt. of green material were put in; at the end of the season 11 tons of silage remained in the bottom and 96 tons 7 cwt. of silage were used, accounting for 107 tons 7 cwt.; the wastage, therefore, was 18 tons or 14.3 per cent, of which 2 tons 1 cwt. 56 lb. consisted of material at the top unfit for use. The wastage under the conditions obtaining at the Institute farm would, therefore, appear to be about 14.0 per cent. The silage has been of excellent quality each year, and on two occasions the seeds aftermath has been made into silage, when the weather conditions were unsuitable for making it into hay.

Nitrogenous Manuring of Pasture Land.

In 1925 arrangements were made with the British Sulphate of Ammonia Federation to carry out an experiment on nitrogenous manuring over a period of years. Four paddocks, of approximately 3½ acres each were fenced off, water laid on, and each paddock grazed by lots of cows during the summer, so that a measure might be obtained of the natural differences in the productivity of the different paddocks before the experimental manuring was commenced. It was decided that all paddocks should be intensively stocked and that two paddocks should receive the experimental nitrogenous manure, the other two being maintained as controls.

The history of the pasture, the applications of artificial manures, and the dates when grazing commenced and the number of cow-grazing days for each pair of paddocks are given concisely below.

<i>History of Pasture (28 acres).</i>		<i>Manuring.</i>
Up to 1917.	Old Permanent Pasture.	
1918.	Cereal Crop.	
1919.	Cereal Crop.	
1920.	No Crop. Weeds with a sprinkling of White Clover and Meadow Foxtail. Purchased by the National Institute for Research in Dairying in October.	December. 10 cwt. Basic Slag (36%) per acre.
1921.	Pasture improving.	
1922.	Ditto.	
1923.	Ditto.	
1924.	Ditto.	December 7 cwt. Basic Slag (36%) per acre.
1925.	February. Western half of field selected for experiment.	March. 25 cwt. Ground Lime per acre on whole experimental area.
	April. Divided into four paddocks and all paddocks grazed by cows, semi-intensively, and records of grazing days, etc., kept.	November. 4 cwt. Kainit (20%) on whole experimental area.

National Institute for Research in Dairying, Reading.

DAIRY HUSBANDRY DEPARTMENT.—continued.

Paddock I. Control. 3.88 Acres.	Paddock II. Experimental. 3.54 acres.	Paddock III. Control. 3.50 Acres.	Paddock IV. Experimental. 3.88 Acres.
1925 { No Manure.	Oct. 1925— 4 cwt. Basic Slag. Dec. 9, 1925— 1½ cwt. S. Ammonia.	No Manure.	Oct. 1925— 4 cwt. Basic Slag. Nov. 17, 1925— 1½ cwt. S. Ammonia.
1926 { Grazed down five times be- tween Apl. 29 and Nov. 29.	May 3, 1926— 1 cwt. S. Ammonia. July 15, 1926— 1 cwt. S. Ammonia. Grazed down five times between April 25 and Nov. 18.		Feb. 23, 1926— 1 cwt. S. Ammonia. May 27, 1926— 1 cwt. S. Ammonia. Grazed down six times between March 27 and Dec. 10.
1927 to Oct. 14 { Grazed down six times be- tween Apl. 17 and Oct. 14.	Feb. 10— 1 cwt. S. Ammonia. June 9— 1 cwt. S. Ammonia. July 19— 1 cwt. S. Ammonia. Grazed down seven times between April 7 and Oct. 12.	No Manure. Grazed down six times between April 12 and Oct. 10.	Jan. 31— 1 cwt. S. Ammonia. June 9— 1 cwt. S. Ammonia. July 19— 1 cwt. S. Ammonia. Grazed down seven times between March 29 and Oct. 10.

RESULTS.

The figures for the two control plots and two experimental plots have been added together to obtain the results given below.

Number of Cow-Days Grazing.

	1925		1926		1927	
	No. of days	Per cent.	No. of days	Per cent.	No. of days	Per cent.
Control	1211	100	1217	100	1123	100
Experimental	1256	103.7	1582	130	1653	147

Milk Yield (in Pounds).

	1925		1926		1927	
	Pounds of milk.	Per cent.	Pounds of milk.	Per cent.	Pounds of milk.	Per cent.
Control	17455	100	18012	100	17935	100
Experimental	17567	100.6	23248	129	27269	152

DAIRY HUSBANDRY DEPARTMENT.—*continued.*Concentrates fed to Cows (*in Pounds*).

	1925		1926		1927	
	Pounds of Concentrates.	Per cent.	Pounds of Concentrates.	Per cent.	Pounds of Concentrates.	Per cent.
Control	2140	100	2122	100	3226	100
Experimental ..	2104	98	2601	123	4039	125

Note :—For the periods March and April, when cows were grazing during the daytime only, each day's grazing is taken as one-third cow-day, and one-third of the milk yielded, and one-third of the concentrates eaten during these periods are included in the above tables.

The above figures indicate that the experimental manuring in 1927 under the conditions obtaining at Shinfield have shown so far approximately a 50 per cent increase over the plots not receiving any nitrogenous manure, all plots being intensively grazed at the rate of seven to nine cows per acre during each grazing period. No difficulty has been experienced in carrying out the experiment but careful attention is needed in admitting and removing stock at the correct time. Samples of the herbage as grazed by the cows have been taken during the summers of 1926 and 1927 for chemical analyses, and careful observations are also being made as to any changes which occur in the prevalence of grasses and clovers in the different paddocks. A botanical analysis was made in 1925 and another will be made in 1928.

Winter Rations for Yearling Heifers.

Experiments have been carried out during the last three winters on the feeding of yearling heifers which were being reared to come into the dairy herd.

During the first two winters the basal rations consisted of 8 lb. hay, 8 lb. silage, and 24 lb. roots, and different additions of concentrates were made to the various groups, and the heifers were kept in yards during the periods of experimental feeding. Last winter one group received hay only and the other group received hay, roots and meal and both lots were turned out on a short pasture during the day. The results obtained each year are tabulated below and show the rations, increase in live weights, and notes on the appearance of each group.

Group	Daily Ration.	Live Weight increase per head daily.	General appearance.
I. 4 Heifers 1925	8 lb. Hay 8 lb. Silage 24 lb. Roots	0.54 lb.	Unsatisfactory. Heifers in poor condition.
II. 4 Heifers 1925	As above, with $\frac{1}{2}$ lb. dec. ext. Earthnut Meal	0.62 lb.	Unsatisfactory. Little better than Group I.
III. 3 Heifers 1925	As above, with 1 lb. dec. ext. Earthnut Meal	1.14 lb.	Fairly good, but lacking a little in condition.

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DAIRY HUSBANDRY DEPARTMENT—continued,

Group	Daily Ration.	Live Weight increase per head daily.	General appearance.
IV. 5 Heifers 1926	As above, with 1 lb. dec. Ext. earthnut Meal, $\frac{1}{2}$ lb. ext. Palm Kernel Meal.	1.63 lb.	Very satisfactory. Heifers in good con- dition and bloom.
V. 5 Heifers 1926	As above, with 1 lb. dec. ext. Earthnut Meal, 1 lb. ext. Palm Kernel Meal.	1.49 lb.	Very satisfactory. No gain from the extra $\frac{1}{2}$ lb. Meal.
VI. 4 Heifers 1927	16 lb. Hay Grazing during day.	0.50 lb.	Condition poor, but with good coats.
VII. 4 Heifers 1927	12 lb. Hay 10 lb. Roots 2 lb. Palm Kernel Meal. Grazing during day.	1.19 $\frac{1}{2}$ lb.	Satisfactory in every respect.

CHEMICAL DEPARTMENT.

THE CHEMICAL CONSTITUTION AND OTHER PROPERTIES OF MILK AND MILK PRODUCTS.

BACK TO THE LAND. The tendency of modern chemical science is "back to nature," and from this point of view the removal of the National Institute for Research in Dairying to its natural environment, the farm and dairy, was most opportune.

The problems for dairy research which present themselves in the light of recent advances in the sciences of biochemistry and physiology, are almost overwhelming. These problems naturally centre around the chemical constitution and other properties of milk.

MILK AS THE LINK BETWEEN SUCCEEDING GENERATIONS OF MAMMALS.

Milk is a wonderful fluid produced by all mammals for the nourishment of their young after birth, forming a link between succeeding generations. It is a white or whitish liquid, produced directly from the blood, but to the production of which the other organs and even the bones of the skeleton of the parent, contribute.

The Scope of the Problem.

The conversions of matter and energy which take place during the short interval of time which elapses between the production of milk and its re-conversion into the substance of the young animal are but little understood.

The factors which determine the nature of the milk of individual cows can be studied, and it is seen that not only management and feeding, but even the soil on which the food of the cow grows will have an influence, long suspected but never accurately defined, on the composition of milk, its nutritive value, and its suitability for cheesemaking and other processes of the dairy industry. From recent work it would appear that even so remote a factor as the sun has a great effect on the nature of the food, and also on the milk which is produced in the cow's body from such food.

The analytical study of samples of milk in a town laboratory is necessarily restricted in its scope, and the influence of the factors above mentioned on the resulting milk and milk products may escape detection. It is not possible to obtain necessary knowledge on the chemistry of milk from a study of isolated chemical constituents.

The importance of the reactions between different constituents and groups of constituents of the milk itself is great, and is well illustrated by the study of the following very fundamental property of milk.

MILK AS A COAGULATING LIQUID.

In nature, milk never sees the light of day, but passing from the teat of the mother to the stomach of the suckling animal, is changed, first, into a more or less solid substance, and after digestion is transformed into the blood and tissue of the young animal.

This coagulation is common to the milk of all mammals, but in very varying degrees. Its significance is not fully understood, although it has been utilised for centuries and is the fundamental basis of the ancient industry of cheese making.

The results of our experiments on raising sucking-pigs by hand published in the Pig Breeder's Annual 1928-29 show that the cheesy clot which may be formed in the stomachs of little pigs fed on cows' milk contains more fat than protein and that coagulation can be prevented by emulsification of the fat. In this case the curd is detrimental, sometimes causing the death of suckling pigs. It seems certain, however, that such a marked characteristic in the nature of milk of different animals as the quantity of the curd produced must have an influence on the young of each species which is worthy of further investigation.

Coagulation by means of Rennet.

The coagulation of milk which is brought about naturally in the stomach of all mammals by the action of the enzymes present is produced in the manufacture of cheese by the addition to the fluid milk of a solution of rennet—the rennet being made by extracting the lining of calves' stomachs and being, in effect, a solution of the enzymes which are present in the natural condition.

The time which is taken for milk to coagulate on the addition of rennet is a most important factor in cheese making, and also serves as a means of estimating the strength of the rennet solution. A suitable and simple technique for the determination of this time factor has been worked out in this laboratory.

In addition to the strength of the rennet solution other important factors influence the time of coagulation. Of these perhaps the three most important are—Reaction, Temperature and the presence of Calcium Salts.

CHEMICAL DEPARTMENT.—continued.

Milk with the reaction at which it leaves the udder of the cow coagulates readily into a firm clot on the addition of rennet, provided the temperature is not below 84 deg. F., or above 105 deg. F. In the manufacture of certain types of cheese, however, it is necessary that a coagulum should be formed more rapidly than it would be under these conditions, and to produce this the milk is rendered more acid by the addition to it of a culture of lactic-acid-producing organisms or "Starters."

If milk is heated to a temperature of 165 deg. F. or above for 30 minutes it is found that it will no longer coagulate on the addition of rennet; while if heated to temperatures lower than this, but higher than 105 deg. F the time of coagulation is usually longer than for raw milk, and the coagulum formed is soft and drained only with difficulty.

This type of curd can generally be obviated by the addition to the milk of a small quantity of a solution of a calcium salt—the resulting coagulum then formed on the addition of rennet being firm and solid and approximating to the curd formed from a raw milk.

The fact that a soft sloppy coagulum is formed from milk which has been heated seems to indicate that the heating has affected the action of the calcium salts, and an investigation into a possible reason for this is being made.

Effect of Caseinogen on the Secretion of lime salts.

Studies of the renneting properties of milk lead on to work on Calcium Metabolism, and preliminary laboratory experiments carried out by physico-chemical methods have indicated the very significant part played by caseinogen in the control of the secretion of calcium in milk. The effects produced by very large doses of certain inorganic salts on the calcium content of the blood and of the milk of lactating cows have also been investigated.

The results indicate that it is extremely difficult by such means to effect any significant alteration in these constituents, or in the yield and composition of milk.

The close inter-relationship of these problems is illustrated by the significant part played by the calcifying vitamin (Vitamin D) in calcium assimilation and in the resulting calcification of the bones. In this connection it is worthy of note that a cow fed on a deficiency of fat-soluble vitamins will deplete her skeleton to the extent of one quarter of its calcium content in the endeavour to make up calcium deficiencies in her milk.

MILK AS A FOOD.

Recent research has clearly demonstrated that milk is something more than a mixture of fats, carbohydrates, proteins, and ash constituents, and water.

If these constituent parts, which are separated by the analysis of milk, be purified and mixed together, they are found to be incapable of alone sustaining growth and development in animals, and various diseases result from the use of such a diet. The nutrients are valuable in themselves as energy producers and flesh and fat formers, but other factors which cannot be separated by analysis, called Vitamins, are also be proved to be necessary.

CHEMICAL DEPARTMENT—continued.

Vitamins in Milk. The physical condition in which the nutrients exist, and their chemical associations are also of importance in nutrition as was shown in the case of the casein calcium complex, for example.

Even before the new laboratories at the Institute were available, pig feeding experiments were undertaken to investigate the nutritive value of milk and milk products. These experiments were conducted in co-operation with Professor Drummond and Dr. Coward of the University of London, and Dr. Zilva and Miss Soames of the Lister Institute, as the London workers were glad to avail themselves of the facilities afforded by the farm for experiments on pigs and cows.

The investigation of milk from this new point of view has been very fruitful in results. In particular it has been shown that the Fat Soluble Vitamin, which is found in cream and butter, contains two separate factors, Vitamin A, promoting growth, and Vitamin D, preventing rickets.

Further, although the cause of rickets in pigs was obscure at the commencement of these experiments, it was possible to demonstrate true rickets in eight out of ten experimental animals fed on a diet of separated milk and toppings and barley meal, to which additional phosphate and lime had been added. The pigs were kept in a sty away from direct sunlight.

Other animals kept under the same conditions and similarly "off their feet" were restored to normal health, either by the addition of cod liver oil to the ration, or by feeding with fresh full-cream milk instead of the dried separated milk, or by exposure to direct sunlight. At the commencement of these experiments the growth of all the pigs was good, from which it was concluded that the very small amount of the growth promoting vitamin necessary for pigs was supplied by the dried separated milk, which, however, was deficient in the vitamin which prevents rickets.

In the earlier experiments in which caseinogen heated to destroy traces of Vitamin A was used, growth was practically stopped, while in control groups to which cod liver oil was added to the ration, pigs grew well.

Source of Vitamins in milk. In a series of experiments extending over seven years and involving prolonged feeding of over sixty cows in all, the vitamin content of the butter made from the milk of stall-fed cows in winter time has been investigated. It has been demonstrated that such feeding may reduce the growth promoting properties of the butter to one-tenth of its summer value. The summer value in Vitamin A may be obtained by adding cod liver oil to the ration, the butter still remaining white.

Further experiments have shown that there are differences in the vitamin content of winter foods in common use, for instance, meadow hay is richer in these factors than seeds hay. Green kale enriches the milk in Vitamin A, but not in Vitamin D.

The influence, if any, of the vitamin content of the food on the yield and composition of the milk, and on the health of the cows is also being investigated.

CHEMICAL DEPARTMENT—continued.

MILK AS A SOURCE OF NUTRIENTS. It has long been considered that it is of the nature of any particular cow to yield milk of a certain quantity and quality, always providing that an adequate diet is given, and the milking and general management is efficient. Recent work in animal husbandry has indicated that the quantity may be increased by methods of feeding and management; this subject falls within the domain of Animal Husbandry, and is being investigated.

The factors influencing quality, however, are more obscure, and must be considered from a physiological aspect.

Milk Fat. With respect to the percentage of fat in milk an unexpected discovery has been made at the Institute in the course of a series of investigations mentioned above, on the influence of the fat soluble vitamins in the food on the quality and quantity of the milk yield.

In the course of these experiments cod liver oil was added to the winter food of stall-fed cows. The unexpected result was that a definite fall in the percentage of fat was noted during the period in which liberal supplements of cod liver oil were given.

The results of these experiments were published in a paper read before the World's Dairy Congress, 1928, on "Some of the Effects produced on the richness of cows' milk by feeding cod liver oil," and also contributed to a discussion on "Lactation" at the Glasgow meeting of the British Association.

With regard to the depression of fat in milk by feeding six to eight ounces of cod liver oil the position is as follows:—That the depression observed varies with different consignments of oil, sometimes four, sometimes six, and sometimes eight ounces per day per cow being necessary to produce the effect.

A study of the results indicate that it is not the oil itself which produces this result, but a constituent which varies in quantity.

The result has practical importance, as a caution against too liberal use of this potent and valuable oil for cows in milk, but from the scientific standpoint it affords a method for the investigation of the principles underlying the formation of fat in milk, an aspect which is now receiving attention. Other oils have also been added to the food of the cows, and an attempt is being made to discover the reason for this unexpected result in the case of cod liver oil, and its bearing on the formation of fat in milk.

In the above mentioned series of experiments, analyses have been made of the milk of all the experimental cows at each milking throughout the lactation period. The mass of figures accumulated will soon be available for statistical study, and will be of special importance in providing information when the Regulations governing the composition of milk which is intended for sale come up for reconsideration and necessary amendments.

In all the above mentioned work, it has been necessary to evolve a technique for the experiments and to check the method of analysis.

CHEMICAL DEPARTMENT—continued.

A paper has been published on the correct technique of the Gerber test and the "Hoyberg test" a suggested new method of analysis and test for fat in milk has been investigated and forms the subject of a paper in the Journal of the British Dairy Farmers' Association, Volume XL, 1928.

MILK AS RAW MATERIAL. The chief products of the dairy industries, cream, butter and cheese are based on methods of manufacture of great antiquity, the fundamental principles being apparently very simple, though, in common with other natural phenomena which have been evolved by a process of selection, they frequently depend on factors which are not easily understood.

Butter. For example, in our experiments on churning cream from the milk of individual cows, unexplained differences in churnability have been observed.

Cheese. Most work of this character has, however, been devoted to cheese-making, and one fault, yellow discolouration in Stilton Cheese, has been thoroughly worked out. This research, to which many years have been devoted, has been very fruitful in results, and has demonstrated the extent to which hydrogen-ion concentration may modify the reactions produced by a particular organism, indicating the value of the control of acidity as a method for preventing the trouble.

By-Products. The ancient industry of cheese making was developed on the farm. It consisted in abstracting half the solids of milk in the solid and portable form; the by-product whey, being converted into pork by feeding to pigs. In the butter and cream industries the fat alone was abstracted and the remaining separated milk was used for calf rearing and pig feeding. Modern engineering developments and improvements in transport have altered conditions, and the milk is frequently conveyed to central factories where pigs are not available and the resulting waste and the insanitary conditions resulting from running whey into drains, have crippled the development of the industry on commercial lines.

Separated milk is frequently dried on roller driers and in this form finds increasing use as a human food; but the cost of the process has militated against a similar method being used for whey, which contains over 93 per cent of water.

Dried Whey. A method has, therefore, been devised at the Institute, by means of which the waste heat from the rollers is utilised for heating more whey. This method effects a considerable concentration of the liquid and economises steam.

A method has also been devised for drying a mixture of separated milk and whey. Both products are good for bread making and improve the flavour and keeping qualities of bread, which contains about one part of the dry product to ten parts of flour. They may also be used to advantage in smaller proportions.

Pig-feeding Experiments. Dried whey, condensed whey, dried butter milk, semi-solid butter milk and other dairy by-products have been used in pig-feeding experiments. All dairy by-products give good results when added to the diet of a growing pig.

CHEMICAL DEPARTMENT.—continued.

The outstanding feature is the very small quantity which seems necessary to produce a quite definite gain even when the basal ration is good.

Milk as a food for pigs. A series of experiments has been carried out in which half a pint of fresh milk was added to a well-balanced and adequate diet for a porker, the control animals being given equal nutrients in the form of extra basal diet. The first 25 pigs fed in this manner gave an increase of about 7 per cent or more over the control animals. The experiments are being repeated and other basal mixtures tried.

BACTERIOLOGICAL DEPARTMENT.

THE METHODS OF HANDLING AND DISTRIBUTION OF MILK.

The Need for Investigation on the Subject. Research problems may be undertaken for at least two different reasons. The worker may note an effect which he does not understand and may, for the pure love of his work, set himself to find the solution. Such investigations may have no apparent relation to immediate needs, but in the end it will be found that all new knowledge fits in its place and some of the finest work that has ever been carried out has been initiated in this way. On the other hand a body of men may be invited to consider the needs of an industry and carry out work to promote the progress of that industry. The two positions are not identical, for, in the latter case, the research worker must first investigate those problems which are in most urgent need of solution in the interests of the industry. This was the position of the National Institute for Research in Dairying; and thus it was that the study of the problems of the handling, carriage and delivery of milk has formed such an important part of its work as it has been found that the lack of accurate knowledge concerning the proper methods of carrying out these processes was the cause of grave financial loss to the industry and was also a hindrance to the increased sale of milk. It may be taken as an axiom that there can be no increasing demand for a food stuff which cannot be relied upon to remain sweet in the consumer's house.

Early Work. The investigations were originally carried out in an old cow-shed, under conditions which were certainly worse than those which would be found on an average dairy farm. The results showed quite clearly the immense influence which cleanliness and the sterilisation of all utensils have upon the bacteriological content and keeping qualities of milk. They also showed that, although it may be possible to produce clean milk in very bad surroundings, it is an economy of labour to make the surroundings reasonably comfortable; it is also a great encouragement to those who are actually responsible for the work. It was further made clear that nothing less than true efficiency was of any avail and that some of the methods which had hitherto been thought to suffice for the work had no true value. As an example of the kind of work that has been carried out a table is shown below demonstrating the relative influences of scalding and sterilisation upon the keeping qualities of milk which had been put into utensils that had been treated in one or other of these ways.

BACTERIOLOGICAL DEPARTMENT—continued.

TABLE I.

WASHED ONLY.		WASHED & SCALDED		WASHED & STEAMED	
10 gall. churn.	17 gall. churn.	10 gall. churn.	17 gall. churn.	10 gall. churn.	17 gall. churn.
1 day	1 day	1½ days	1½ days	3½ days	3½ days
1 day	1 day	1½ days	1½ days	3 days	3 days
1½ days	1½ days	2½ days	2½ days	3 days	3 days
1 day	1 day	1½ days	1½ days	3 days	3 days

Development of the Problem. The facts shown above give some indication of the work that was carried out at the farms, but if the work was to be of any avail it had to be extended so that it might include the carriage of the milk and its delivery at the dealer's premises. It was necessary to find out the length of time during which milk must remain sweet if its sales are to increase, to study the problem under winter and summer conditions, and to consider what steps could economically be taken to ensure the satisfactory condition of the milk at all seasons of the year. It was also necessary to give such advice and help to the dairyman as to ensure the proper handling of the milk on arrival at his premises. The need for such work is demonstrated in Table II, which makes it clear that the farmer was not alone in failing to realise the necessity for the efficient washing and sterilisation of milk churns if satisfactory work was to be done, but that the dairyman also failed in this respect.

TABLE II.

Bacteriological Examination of Empty Churns at a Railway Station.

Condition of Churn.		Counts No. of colonies of bacteria per 1 c.c.	Bacillus coli present in
Unwashed whole milk present		Uncountable in	
"		1/100,000 c.c.	+ 1/100,000 c.c.
"		4,000,000	+ 1/100,000 c.c.
"		Uncountable in	
"		1/10,000	+ 1/10,000 c.c.
Badly washed (Milky water present)		18,400,000	+ 1/1000 c.c.
"		5,300,000	+ 1/1000 c.c.
Apparently clean, but wet		4,100,000	+ 1/100 c.c.
"		780,000	+ 1/10,000 c.c.
"		510,000	+ 1 c.c.
"		6,200,000	+ 1/1000 c.c.
"		1,720,000	+ 1/10,000 c.c.
"		21,600,000	+ 1/100 c.c.
"		800,000	+ 1 c.c.
"		400,000	+ 1/1000 c.c.
"		35,000	+ 1/10 c.c.
"		15,400	+ 1 c.c.
"		6,500	—
"		5,000	+ 1/10 c.c.
"		3,000	—
"		2,400	—
"		2,000	—
"		170	—

BACTERIOLOGICAL DEPARTMENT—continued.

The Washing and Sterilisation of Milking Machines. The importance of efficient sterilisation of milking machines has not been sufficiently realised, either by the makers of these machines or by the industry as a whole.

The results of work on this subject carried out at the Institute on two milking machines are given in the following tables.

TABLE III.
Bacteriological Condition of milk from Milking Machine 1.

Date 1928.			Sterile Unit.	Washed Unit.
			Count. B. coli.	Count. B. coli.
June	18	...	300 —	20,000 —
"	19	...	150 —	10,000 + 1/10 c.c.
"	20	...	250 —	300,000 + 1/100 c.c.
"	21	...	150 —	300,000 + 1/10 c.c.
"	22	...	2,200 —	3,600 + 1/10 c.c.
"	25	...	150 —	500,000 + 1/100 c.c.
"	26	...	200 —	160,000 + 1/10 c.c.
"	27	...	300 —	2,000 + 1 c.c.
"	28	...	400 —	70,000 + 1/10 c.c.
"	29	...	100 —	800 —
July	2	...	150 + 1/100 c.c.	1,200,000 + 1/1000 c.c.
"	3	...	150 —	2,000,000 + 1/100 c.c.
"	4	...	150 —	2,000,000 + 1/1000 c.c.
"	5	...	1,000 —	400,000 + 1/100 c.c.
"	6	...	2,100 —	1,200,000 + 1/100 c.c.

TABLE IV.
Bacteriological condition of milk from Milking Machine 2.

Date 1928.			Sterile Unit.	Washed Unit.
			Count. B. coli.	Count. B. coli.
June	18	...	200 —	2,400,000 + 1/100 c.c.
"	19	...	500 —	4,800,000 + 1/1000 c.c.
"	20	...	750 —	8,000,000 + 1/100 c.c.
"	21	...	300 —	560,000 + 1/10 c.c.
"	22	...	440,000 + 1/10 c.c.	2,400,000 + 1/10 c.c.
"	25	...	500 —	4,000,000 + 1/100 c.c.
"	26	...	400 —	30,000 + 1/10 c.c.
"	27	...	300 —	16,800 + 1 c.c.
"	28	...	200 —	190,000 + 1 c.c.
"	29	...	1,900 —	400 + 1 c.c.
July	2	...	100 —	1,400,000 + 1/100 c.c.
"	3	...	300 —	4,000,000 + 1/10 c.c.
"	4	...	200 —	3,200,000 + 1/100 c.c.
"	5	...	500 —	900,000 + 1/10 c.c.
"	6	...	300 —	2,750,000 + 1/10 c.c.

In these tables the bacteriological condition of the milk which had been taken into sterilised and washed units is shown. In each case cows were divided into two lots. At each milking the milk from one lot was taken into a washed unit, and from the other into a unit which had been sterilised. Washing of the cows and of all units was carried out with great efficiency, and the lots of cows were interchanged periodically, that the presence of a cow with a high udder bacteriological content in any lot might not falsify the results.

BACTERIOLOGICAL DEPARTMENT—continued.

The tables show that very efficient washing failed to keep the milking machines in proper condition, since they make it clear that, whereas the milk obtained from the sterile units in each case only show a high bacteriological count on one occasion, and the presence of *B. coli* on two occasions, the bacteriological count of the milk from the washed unit was rarely satisfactory and frequently ran into millions, and *B. coli* were present on almost every occasion, frequently in dilutions as high as one in one thousand. This work was carried out during the summer. In the winter time the results obtained from the washed unit were not so unsatisfactory.

The Use of Disinfectants. It has been thought that possibly steam sterilisation might be replaced by the use of disinfectants, particularly hypochlorites.

It is quite clear that the employment of disinfectants for the sterilisation of dairy utensils carries with it certain dangers.

In the first place, it is necessary that the disinfectant shall be removed from the utensil before it is used for milk. It is, therefore, essential that it shall either be washed or treated with steam. If it be washed then it is clear that the utensil will become re-infected; and if it be treated by steam it seems unnecessary to duplicate the work, since the whole process could have been accomplished with steam alone. If the hypochlorite which has been used for the sterilisation of a dairy appliance be not removed, then some of it will be added to the milk when the appliance is employed in the industry. That this danger is not hypothetical would appear to be true, both from the experience of workers in the United States of America and from the experiments which have been carried out on the subject at the National Institute for Research in Dairying.

In the United States of America this method of sterilisation has been used much more extensively than in this country and the Department of Agriculture has found it necessary to issue a bulletin which describes a method for the detection of hypochlorites and chloramines in milk and cream which would hardly have been done if no danger of their presence had been found to exist. In fact it is not infrequently suggested by those who sell preparations containing hypochlorites that after they have been used, the vessels which have been treated shall be emptied out and then the milk introduced into them. The experiments which have been carried out at the National Institute for Research in Dairying have demonstrated clearly that under such conditions an appreciable quantity of hypochlorite is left in the vessel; and, further, that such vessels require to be rinsed at least twice before they can be said to be free from the presence of hypochlorite and, therefore, in a fit condition for the introduction of milk.

These considerations are sufficient to show some of the difficulties which must arise in the use of hypochlorites even if it be proved that they are really satisfactory substitutes for steam.

In order that this problem might be studied, the values of three proprietary disinfectants have been investigated at the Institute.

Four series of experiments were conducted upon milk churns of 10 and 17 gallons capacity, and the influence of different methods of treatment of the churns upon the keeping quality of milk and of the bacteriological condition of the churns was studied. In the first three series the work was carried out according to the directions supplied with the disinfectants, and with solutions of equal or greater strength than those recommended by the manufacturers. In the fourth series a solution of a strength at least three times greater than that recommended by the manufacturers was employed.

BACTERIOLOGICAL DEPARTMENT.—continued

The results of all these experiments demonstrate that there does not appear to be any true advantage to be gained by using commercial preparations of hypochlorites in preference to steam for the disinfection of dairy utensils.

A National Failure. In practice it is found that the failure to grasp the proper methods of handling milk is not confined to the farmer and the dairyman, but is also true of the public and of very many of our hospital authorities. It has been a national failure, primarily due to the fact that no-one had studied the problems involved in such work and formulated their necessities for the benefit of the industry first and ultimately of the nation. That work the National Institute for Research in Dairying has done, and is doing, for it is not yet complete, with the result that the farmer and dairyman are in a much more secure position than was formerly the case, and are able to guarantee their produce in which they can now take a genuine pride.

This is work which has involved much labour and very thorough investigation of the problems involved. Throughout this work two outstanding facts remained clear. First, that success could only be attained when the right person with the right understanding was in charge of the milk at all stages from the cow to the consumer. Second, that the close co-operation of a great variety of different kinds of people was necessary.

PROGRESS OF THE WORK.

The following short summary of the progress of the work shows that these objects are being attained.

Methods adopted to encourage Clean Milk Production.

Very active measures are being taken in order to encourage the practice of the principles for the proper handling of milk which have been laid down, and it is of some interest to consider these and the great variety of types of people who are engaged in this work.

In the year 1916 the dairy teachers were gathered together by the Agricultural Education Association and plans were considered for modifying dairy teaching in our schools so as to include, amongst other changes, further instruction in the production and handling of milk. The progress of these schemes was promoted by the British Dairy Farmers' Association, which called a meeting of educational authorities in the autumn of 1921. As the result of that meeting a special committee representing most of those bodies which grant Diplomas in Dairying was formed. It was no easy task which that Committee undertook, but at the end of nearly two years a scheme was prepared which has been considered and adopted by the various bodies which were represented. This scheme of education and examination is now in practice under the auspices of the British Dairy Farmer's Association and of the National Agricultural Examination Board, the governing body of the National Diploma in Dairying.

In 1928 representatives from the British Dairy Farmers' Association and the National Agricultural Examination Board met together and decided that it would be of advantage to combine these two examinations into one. This has now been done and a joint board consisting of representatives of the British Dairy Farmers' Association, the Royal Agricultural Society of England, and the Highland and Agricultural Society of Scotland will in future grant one Diploma in Dairying.

BACTERIOLOGICAL DEPARTMENT.—continued.

In the year 1917 Mr. Wilfred Buckley, who was then at the Ministry of Food and was himself one of the pioneers of bottled milk from tested cows in the days when such milk received no official support, instituted, with the co-operation of the Ministry of Health, special licences to those who wished to produce such milk, enabling them to charge an extra price. This was a very important step, since it was the first official recognition of the fact that a better quality milk deserved a better market. Later two types of licence (A and B) were issued, the titles of which were later altered to Grade A (Certified) and Grade A. These licences were only granted to those who were producing milk from cows which did not react to the tuberculin test.

In 1922 the Consolidated Milk Act, which had been passed in 1913 and left in abeyance during the war, was brought into force and the nomenclature of the different types of licensed milk was once more changed and certain new forms of licence introduced. The conditions governing these licences are epitomised in Table V, which shows that it is possible to obtain licences for the sale of raw milk from tuberculin tested cows which is bottled at the farm, similar milk bottled at the dairyman's premises, or milk from cows which are subject to regular veterinary inspection. In addition licences may be obtained for the sale of two types of milk after pasteurization. A very wide choice is thus given to the industry.

TABLE V.

Designation.	Herds		Max. No. of bacilli per c. c.	Coliform bacillus.	Other conditions.
	Tuberculin tested at regular intervals.	Veterinary inspected at various intervals.			
Certified	Yes	Yes	30,000	— 1/10 c.c.	Bottled on farm, the name of farm, day of production, and word "Certified" on each bottle cap.
Grade "A" Tuberculin Tested	Yes	Yes	200,000	— 1/100 c.c.	Delivered to consumer in (a) the bottles or the sealed containers received from the farm; (b) suitable containers of not less than two gallons capacity; (c) bottles with the name of the dealer by whom the milk was bottled, the address of the licensed bottling establishment, the day of production, and the words "Grade 'A' T.T." or "Grade 'A'" on each bottle cap.
Grade "A"	No	Yes	200,000	— 1/100 c.c.	

PASTEURISED MILK.

Grade "A" Pasteurised. Grade "A" milk that after pasteurisation as required by the Minister of Health contains not more than 30,000 bacilli per cubic centimetre and no coliform bacillus in 1/10 c.c. All other conditions as required for Grade "A" milk.

Pasteurised. Any milk that after pasteurisation as required by the Minister of Health contains not more than 100,000 bacilli per cubic centimetre. No requirement for bottling.

BACTERIOLOGICAL DEPARTMENT—continued.

The ultimate success or failure of these types will depend to a great extent upon their quality and price, and the amount of enthusiasm that is put into their sale by the members of the industry.

It is sometimes said that the amount of milk produced under the licensing system is but a fraction of the whole supply; this is true, but none the less the growth is continuous and if it continues at its present rate will represent a very appreciable proportion of the whole milk of the country. This, in spite of the facts that the whole of the initial costs are thrown upon the farmers, the poorest section of the industry, and that the production of such milk does not always meet with the enthusiastic support that might be anticipated. Where such support from the Medical Officer of Health, the industry itself, and those who are interested in agricultural education, is present, good progress has been made, and raw milk, which has been produced under the graded system of licensing, is being sold in increasing quantity throughout the country.

An important result of the graded milk movement has been noted in the increased cleanliness of ungraded milk supplies. This is illustrated by the fact that usually 40 to 60 per cent of the summer samples have reached the Grade A bacteriological standards.

Not only has the Ministry of Health assisted the work by granting licences, but it has given every encouragement to the sanitary inspectors who are responsible for the administration of milk legislation to attend special courses which are held at agricultural colleges for instruction in the principles which are involved in the proper handling of milk.

In 1925-26, 9 courses of this character were held at 7 different centres and 158 inspectors attended. In 1926-27, 15 courses were held at 13 centres and 329 inspectors attended. Concerning these courses the Chief Medical Officer of the Ministry of Health in his annual report for the year 1926 made the following statement:—"The practice of graded milk production, with its appeal to bacteriological standards, has of recent years developed dairy technique into an art with which sanitary inspectors whose duties include the sanitary supervision of dairies, can no longer afford to be unfamiliar. A practical knowledge of this work is necessary for maintaining a proper balance of judgement as to what will satisfy the essentials as regards structure, equipment, and methods which the Milk and Dairies Order empowers him to enforce. Many sanitary inspectors have made themselves familiar with these questions in recent years and their knowledge has been reflected in the improvements which they have been able to bring about in the milk produced in their districts. Many more are engaged in acquiring knowledge and experience of these matters by attendance at classes and demonstrations which have been organised at various centres. The Ministry considered that attendance at such courses would make for more efficient work under the Milk and Dairies Order and would tend to promote uniformity of action under it."

BACTERIOLOGICAL DEPARTMENT.—continued.

TABLE VI.
Courses in Clean Milk Production for Sanitary Inspectors.

Provincial (or similar) Centre.	County Centre (in case of Decentralised Courses).	Figures for 1926-27.		Figures for 1925-26.	
		No. of Courses.	No. of Inspectors attending.	No. of Courses.	No. of Inspectors attending.
Leeds University		2	39	2	31
Reading University		1	17	2	29
Bangor (U.C. of N. Wales)		1	12	1	13
Bristol University		1	14	1	12
Seale-Hayne College		1	18	1	11
Armstrong College		1	17	1	41
Aberystwyth (U.C. of Wales)		—	—	1	21
Midland College		2	15	—	—
Harper Adams College		1	6	—	—
	Rodbaston Farm Institute.	1	25	—	—
Wye College		1	8	—	—
Manchester University		1	138	—	—
Moulton Farm Institute		1	12	—	—
Cheshire School of Agriculture		1	8	—	—
	TOTAL	15	329	9	158

In addition to granting licences the Ministry of Health has brought the Consolidated Milk Act into force and with it the Tuberculosis Order. The former lays down the requirements for light, ventilation, water and the care of milk.

In practice the Ministry of Health has made every effort to encourage the local authorities to make these requirements practical and clear and there is little doubt that the effect of this Act will be to promote steady improvement in the conditions upon dairy farms. The Tuberculosis Order will also tend to eliminate at least the worst cases of tuberculosis from the herds in the country, a movement which is being still further promoted by the constantly increasing numbers of farmers who

BACTERIOLOGICAL DEPARTMENT—continued.

are taking up Certified and Grade A (T.T.) licences, and by all those who take out Grade A licences which involve veterinary inspection and thus automatically exclude the cows before they have reached any very advanced stage of tuberculosis. These facts, together with improved light and ventilation in the cowshed, and the steadily improving knowledge of our farmers concerning the best principles of feeding, must lead before many years are passed to a very considerable reduction in the amount of a disease which has been a scourge to the dairy farmer in the past.

The work of the Ministry of Agriculture is of many different kinds. It is responsible for the county clean milk competitions which were originally started in Essex in 1920 by Howards Dairies, and as Table VII shows have increased in number from one in 1920 to 38 in 1926-7, that is to say, that during 1927, at least 1000 farms scattered all over England and Wales were engaged in competing one against another to see which of them could produce the cleanest milk. At one time United Dairies also organised clean milk competitions in one or two counties; these have now been incorporated into the general scheme. In 1927 a new element was introduced into this work, and an inter-county competition for the Stapleton Cup, which was given under the auspices of the British Dairy Farmers' Association, was held. Eighteen counties entered and eleven actually competed, and those who had the privilege of judging the results were astonished at the high standard that was maintained by the competitors in these counties.

TABLE VII.
Comparative Statement of Clean Milk Competitions.

Year.	No. of Counties	No. of Competitors.	No. of Cows.
1920	1	—	—
1921	2	—	—
1922	3	—	—
1923-4	7	181	4,662
1924-5	24	563	15,467
1925-6	32	818	20,695
1926-7	38	1,062	28,520

In addition to the scheme of clean milk competitions the Ministry of Agriculture has set up Advisory Bacteriological posts at the provincial centres throughout the country. It is the duty of those who hold these posts to test samples of milk on behalf of the farmer and the dairyman, to carry out investigations themselves, and to give all the help and advice that is in their power. The Ministry has also appointed instructors in the counties to visit the farms and advise and assist those who are anxious to improve their supplies.

Some have felt that it is just as important for those who are in the dairy trade to have a thorough knowledge of the methods of handling milk as it is for the farmer, since success can only be attained by complete combination between the producer and the dealer. For these reasons every support has been given to the Chelsea

BACTERIOLOGICAL DEPARTMENT—continued.

Polytechnic in carrying out the classes which it holds for the study of milk. Those classes are a great success, as is shown by the facts that in 1926, 52 students were on the register, with an average attendance of 45, and in 1927, there were 65 students on the register, with an average attendance of 56. It is interesting to note that the majority of these were the smaller dairymen in and around London, and the roundsmen and foremen from the larger distributing depots. It is quite clear that these classes ought to be extended, and it is difficult to understand why this has not already taken place, since the Ministry of Agriculture and the Board of Education and many of the dairymen in London are anxious that progress shall be made.

The industry itself has made great strides since the days when a few people, like Mr. Buckley and some others, were producing clean milk and creating their own markets without any official support. Those who are in contact with the trade find that two things are taking place; on the one hand, there is an increasing desire to make use of scientific knowledge. That this is true is shown by the work which is being done by United Dairies, by the Sterilised Milk Companies both in London and in Birmingham, by Howards Dairies in Southend, and many others, but it is also true of much smaller businesses than any of these. The members of the trade usually proceed in one of two ways; either they set up laboratories of their own or they appeal to the nearest provincial centre to carry out the work for them. In either event the spirit is the same, and is making for material progress, since the dealer not only obtains a cleaner milk, but also finds its increased monetary value to him and is prepared to pay a better price for it.

In the past it was true that a certain number of farmers could obtain an increased price, either because their milk was readily available, or because of its extra keeping quality, but such cases were comparatively rare, and there was no recognised system by which the farmer received a better price for a better quality. Lately, however, the industry has begun to take up the attitude that such a price should be paid. The Midland Counties Dairy, Birmingham, is a notable example of this kind. Some dairymen, both in Reading and in London, who are working in collaboration with the National Institute for Research in Dairying, are also adopting this method. In all cases regular examinations of the milk as it reaches the dairyman are carried out and upon the results the extra payment is made, either as a bonus to those whose milk is the cleanest or as a regular payment to each farmer if his milk attains a certain standard. The latter method is the better, since it ensures that every farmer who attains the standard receives extra money. The bonus system, which is usually limited to a certain number of those farmers who are sending in milk, may easily exclude farmers whose work has been quite excellent but did not attain the very top marks.

The extra price which the farmer receives for his milk varies from $\frac{1}{4}$ d. to 2d. a gallon, a valuable addition to a farmer's income for milk which is not being sold under licence.

Considerable stress has been laid upon the studies of the handling of milk which have been carried out at the Institute. It is right that this should be so, for they represent not only one of the greatest needs of the industry but are also essential for the proper study of many of the research problems which the Staff of the Institute is undertaking. It is not possible, for example, to make a satisfactory study of the influence of different types of "starter" upon milk if the milk itself be already contaminated by extraneous bacteria; for then the whole problem is complicated by the effect produced not only by the "starter," but also by the extraneous bacteria.

BACTERIOLOGICAL DEPARTMENT—continued.

What is true in an experiment of this sort is equally true of many of the other problems which are under investigation. It was, therefore, essential that the staff of the Institute should be in possession of a really clean milk supply if it was to do its work satisfactorily. Now that this is so the study of the problems concerned with the satisfactory production of butter and cheese, particularly Cheddar and Stilton, are being undertaken, and it is hoped that in time it may be possible to secure a cheese of uniform quality. These problems are difficult, involving as they do a variety of different factors, but progress is being made and it is hoped that satisfactory solutions will be found.

It has been shown that the study of the problems of the proper handling of milk is vital to the development of the milk industries; and is essential to the proper conduct of true research. It would be a mistake, however, to assume that it represents all the work that is being done.

Other Problems. Anyone who pays a visit to the Institute will find members of the Staff engaged upon the study of problems of different types amongst which the following may be mentioned.

Oiliness in Milk. This serious and widespread fault of whole milk has been shown to be due to the presence of very minute quantities of metal, usually copper. Micro-organisms which were at first thought to be the cause of the taint, have been isolated, studied and shown to play a part in the limitation of the trouble to cold weather. For practical purposes it is only necessary to avoid untinned copper surfaces to suppress an outbreak, whether on the farm or in the milk depot.

Keeping Qualities of Cream without Preservatives. In view of the prohibition of the use of preservatives in cream, experiments have been undertaken to discover the keeping quality of cream without preservative.

It appears that from clean raw milk, using a sterile separator, the keeping quality of the cream is about equal to that of the milk from which it came.

Pasteurisation of the milk or of the cream adds considerably to the life of the cream from clean milk.

With ordinary commercial milk, pasteurisation of the cream is necessary to ensure even a moderate keeping quality. Unheated cream from clean milk and pasteurised cream from ordinary milk will keep quite sweet for about twenty days in cold store at 40 to 45 deg. F. After removal from cold store the average life of the cream is not more than two days at summer temperature.

Sterilised Milk. The weekly routine examinations of samples of commercial sterilised milk have now been discontinued. These studies have confirmed the fact that the characteristic acid-producing and digesting organisms may be found in the sterilised milk at all seasons of the year, although during the colder months they do not usually develop sufficiently to cause taints.

A considerable number of organisms have been isolated from the sterilised milk, and a more detailed study of a typical selection of these is in progress.

The Need for Provision for More Extended Work.

Before indicating the directions in which more extended facilities are required, it will be well to deal first with the present position of the Institute.

The Institute began work on its present basis in October, 1923, when it took possession of the Shinfield Manor Estate. The possession of the farm and dairy and adequate laboratories was obviously essential to the progress of the work, and the purchase of the Shinfield Manor Estate was rendered possible by donations, by loans, and by a grant on the pound for pound basis from the Ministry of Agriculture. The loans have not yet been paid off, and at the present time amount to approximately £23,000 including £8,400 to Lord Iveagh, which he has promised to diminish pound for pound against donations in reduction of the total loans.

It was clear that the new basis must involve developments necessitating increasing annual expenditure as time went on. The farm was neither fully stocked nor fully developed; many of the members of the Staff were quite young and no provision had been made to establish their position and prospects—an essential provision if good workers are to be retained for the work; an increasing wages bill would have to be faced for laboratory attendants and other minor Staff, practically all of whom were in their teens or very early twenties.

The Library, which is an essential part of the equipment of a research institute, was little more than a nucleus, and expansion was imperative.

It has always been held that an income of not less than £16,000 per annum would be required to maintain the Institute on the basis established in 1923. The Ministry of Agriculture now provides an income of about £12,000 per annum, and it has stated that no further provision is likely to be made. The Ministry's grant has always been a grant-in-aid, and it has always been contemplated that other income would be provided by those interested in the welfare of the industry.

In order that an adequate income might be provided an attempt has been made, and is being continued, to raise an endowment fund of £80,000, and towards this sum approximately £17,000 have been received.

Much of the work of the Institute has been carried on by special grants and other adventitious income which carry no guarantee of continuity, and their cessation must result in embarrassment to the work dependent on them. At the present time, a grant of £500 per annum which was financing certain vitamin and feeding studies has been discontinued, while much work still remains to be done.

During the Coal Strike, a grant of £800 a year which the Institute was receiving from the Ministry of Health was discontinued. With this grant, it had been proposed to open a Laboratory in London for the study of London milk, and in order to assist the dairyman in London.

THE NEED for PROVISION for MORE EXTENDED WORK—continued.

The Laboratory would have been situated in the London School of Hygiene and Tropical Medicine, in association with the new School of Hygiene, and in fact every facility had been offered by the authorities of that school for the establishment of the proposed Laboratory. The scheme had several advantages :—(1) the dairymen in London would have been able to obtain the advice and help that they needed in their work, and thus be encouraged to contribute to its cost ; (2) The work would have been carried out by those who have a knowledge of the difficulties which are met with in the dairying world ; (3) It would have been carried out in a Laboratory in which some of the future Medical Officers of Health of this country are being trained, and thus they would have an opportunity of obtaining a better insight than is possible at present into the essentials of the successful handling of milk, and thus be able to administer the legislation which it is their duty to administer with a sympathetic understanding of the difficulties of the industry.

With an income of from £800 to £1,000, a Laboratory of this kind could be started, and a charge could be made for the work done in order to provide funds for its development.

The facilities which were provided in 1913 enabled the Institute to undertake fundamental researches on many problems in immediate need of investigation and to extend work already in progress. The further progress which has now been made has rendered necessary the provision of further facilities which will now be indicated. That most of these would ultimately be needed has always been realised, e.g., a department of physiology and developments at the farm. In view of the present financial position of the Institute, it is felt that these extensions can be undertaken only if funds are made available to maintain them.

(1) Department of Physiology.

The provision of facilities for physiological studies is considered to be a matter of prime urgency. Without such provision the Institute is not in a position to deal with the fundamental problems which lie below some of the more immediate problems with which it is now dealing. In order to gain complete knowledge of milk we must know :—

- (1) The influence of the land upon the crops grown thereon.
- (2) The botanical constitution, food value, etc., of the crop as fed to the cow.
- (3) The influence of the food upon the milk and other particulars necessary to understand the whole physiology of milk secretion.
- (4) The value of milk under varying conditions of feeding, etc., as a food stuff and as a material for the preparation of dairy products.

If the present position of the departments can be maintained, certain aspects of this work can be effectively studied ; we can study the condition of the land and of the foodstuffs obtained from it. We can, with the aid of some extensions, study the milk itself after it comes from the cow.

We cannot, however, study the factors which determine the influence of the foods fed to the cow, on its constitution and on the constitution of the milk, and it is in order to do this that we require a Department of Physiology. The creation of such a department will involve the erection of additional buildings, as all existing accommodation is fully utilised, and provision for the salary and laboratory expenses of a suitable worker.

THE NEED for PROVISION for MORE EXTENDED WORK—continued.

(2) Additional Farm Buildings.

It is obviously essential that in order to meet the requirements of present and future work, a sufficiently large herd of cows shall be maintained, and the necessary accommodation provided. The farm is now capable of carrying a herd approaching the number (60 cows) which it has always been considered should be attained, and which is now required to meet the needs of the research and experimental work. But housing accommodation is insufficient. It has been possible recently, by direct labour, to make some additional provision for young stock by pulling down a dilapidated covered yard and erecting a larger building. This does not, however, furnish any additional accommodation for milking cows, the need for which has become urgent. For this purpose, an extension of the present cow byres and covered yards is desirable, together with the provision of additional covered yards adjoining another existing building.

For some years it has also been pointed out that the provision of a dutch barn would be a real economy as at present all hay and straw crops have to be stacked in the most convenient position, and are subject to the usual risk from delays in thatching, and exposure to weather. The provision of a barn would save labour in stacking, threshing, and thatching, greatly lessen losses from weather, and permit the present rickyard to be again cultivated.

(3) Large Scale Dairying and Testing of Machinery.

One of the results of the application of the knowledge which has been gained as to methods of handling milk and dairy products is that the need has arisen for experiments with different types of large scale dairying machinery, to determine their efficiency in relation to the new standards. Further, manufacturers of dairy machinery and equipment are anxious to have the efficiency of their products tested.

For a long time some work of this kind has been carried out at the Institute on a voluntary basis, in the interests of the industry. It has recently developed into a regular and systematic branch of work, and a special committee has recently been appointed by the Ministry of Agriculture and Fisheries for dealing with applications for the testing of machinery and utensils. This Committee does not possess any funds beyond the small fees it charges for tests, and in fact its contribution to the work carried out last year was a very small proportion of the total costs.

The demand for investigations of this kind is likely to increase and the need for adequate provision for them has become acute. The work is of extreme value to the dairy farmer, and it has a logical relation to the studies being made at the Institute on the production, handling and distribution of milk and the manufacture of milk products. A problem is now under investigation in connection with condensed milk which cannot be worked out without the aid of an experimental plant for condensing and drying milk.

The carrying out of experiments of the kind required necessarily involves a great deal of labour, and at the present time this must be undertaken by members of the Staff who are already fully occupied. It is considered that the work requires the appointment of a whole-time member of staff who shall be primarily responsible, under the Professional Committee for the supervision and conduct of experiments of this character, but who would act in co-operation with other departments of the Institute.

THE NEED for PROVISION for MORE EXTENDED WORK—continued.

The question of accommodation for this work has also been a problem for some time. In the case of milking machines, accommodation must be found at the farm, but for other machinery it is very desirable that there should be accommodation as near as possible to the engineering centre for the production of power, steam, etc.

At the present time, the barn near the engineering centre is being utilised and is now fully occupied. It has been pointed out by the Institute's architects that this barn is not at all suitable for carrying any heavy loads or withstanding continuous vibration. The question of the provision of a suitable machinery hall with a small workshop attached has been considered, and an estimate of the financial expenditure involved has been prepared.

Financial Requirements.

The costs of the foregoing schemes of work fall into two divisions :—

(a) The cost of additional buildings.

(b) The cost of annual maintenance.

(a) The Cost of additional buildings.

It is desirable from an architectural point of view that, in making provision for immediate needs, the possibilities of further extensions of the work at a later time be kept in mind.

A scheme of building has, therefore, been discussed tentatively with the architects of the Institute which will meet the need of the foregoing expansion of the work, and also meet probable needs of the immediate future. Further, the scheme is designed to relieve some of the congestion already evident in the existing buildings, particularly in the Library.

It will be realised that not all of the new laboratories will be required immediately. Below are given the approximate costs of the scheme.

A.	New Laboratories	....	....	....	£15,400	
	Machinery Hall and Workshops	....			4,000	
	Additional boiler for heat, light, power, etc.	....	....	....	1,250	
						£20,650
B.	Farm.					
	Dutch barn	....	....	....	300	
	Extension of new buildings	....		....	1,200	
	New covered yards	....	....	....	650	
						2,150
						£22,800

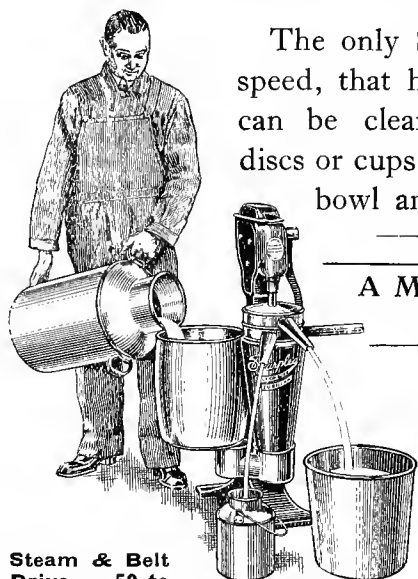
The cost of annual maintenance.

It is estimated that to enable the work to be developed along the lines indicated an additional £3,000 of income will be required to meet the cost of salaries, laboratory maintenance and overhead charges. This represents a capital sum of about £60,000.

Summary of capital Requirements.

(1)	To extinguish existing loan accounts	....		£22,000
(2)	For Endowment	....	£63,000	
	Add cost of new developments		60,000	
				123,000
(3)	New Buildings for extended work			23,000
				£168,000

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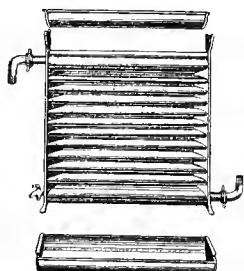
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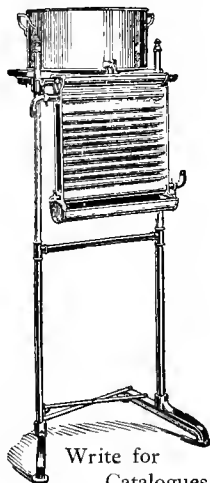
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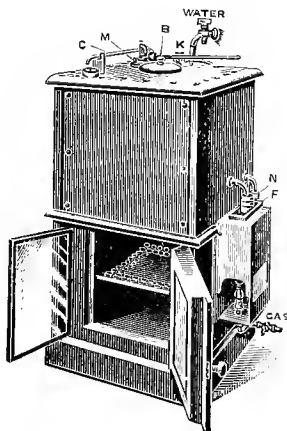
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Ear-mark	Date of Birth.	Calv-ings.	Date of last Calving	Yield of Milk (lb.)	Ear-mark	Date of Birth	Calv-ings.	Date of last Calving.	Yield of Milk (lb.)
3283	Abt. 1917	7	27.10.25	11,473	785	Abt. 1918	4	9.12.25	14,522½
3017	Abt. 1919	4	19.12.25	11,426	1866	Abt. 1916	7	21.11.25	14,342½
2138	Abt. 1919	5	27.1.26	11,358	3018	Abt. 1919	4	28.12.25	14,070
1913	Abt. 1921	3	19.10.25	11,134	1874	Abt. 1914	8	30.11.25	13,801
2473	Abt. 1918	5	Un-known	11,066½	2079	Abt. 1917	7	Un-known.	13,704½
2049	Abt. 1918	6	15.5.26	10,910½	3211	Abt. 1919	4	"	13,127½
1690	Abt. 1916	7	14.2.26	10,565½	2036	Abt. 1918	6	17.2.26	13,057½
3208	Abt. 1919	4	Un-known	10,312½	2038	Abt. 1916	7	Un-known.	12,744½
3050	Abt. 1921	2	17.3.26	10,296½	1901	Abt. 1917	7	11.4.26	12,426½
1915	Abt. 1917	7	28.4.26	10,282½	254	Abt. 1916	7	14.11.25	11,976½
3292	Abt. 1920	3	Un-known	10,265	2455	Abt. 1919	4	24.10.25	11,624
5185	Abt. 1920	3	5.8.26	10,216½	3207	Abt. 1918	5	Un-known.	11,617
3073	Abt. 1918	5	21.1.26	10,168½	1820	Abt. 1916	7	14.11.25	11,599½
2048	Abt. 1919	5	2.6.26	10,148					

Year ending Oct. 1-26—**56** Full-time Cows averaged **9932½** lbs.
 „ Oct. 1-27—**59** „ „ „ **9479** lbs.

N.B. This herd stood First in the Durham Milk Recording Society 1925-6.

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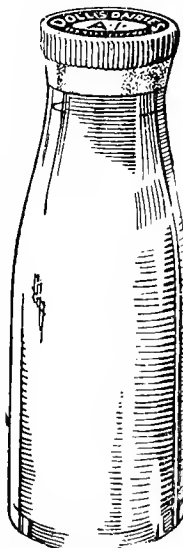
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The Association is constantly endeavouring to persuade the Ministry of Health to simplify the Milk Designations Order, and also to render it impossible for unlicensed farmers and milk dealers to use the term "Tuberculin Tested."

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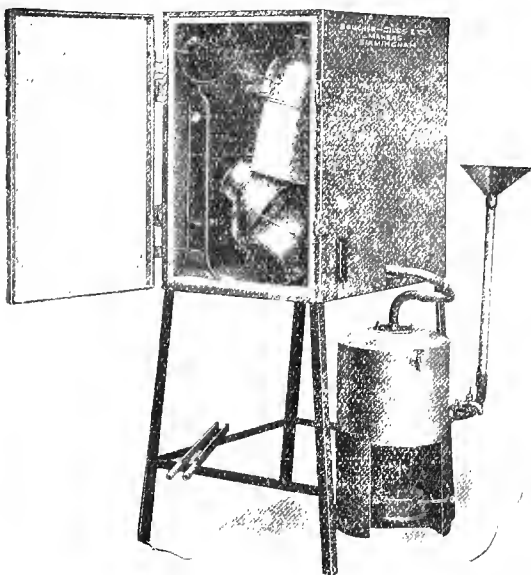
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CLEAN MILK.

Points to be attended to in order to obtain milk with good keeping properties.

SOURCES OF CONTAMINATION.	HOW TO AVOID THEM.
Dirt and dried dung on Cow's hindquarters, flanks, belly or udder, which drops off into milk pail or is rubbed off in process of milking. (This source of contamination is especially troublesome in winter).	(1) Keep cows as clean as possible. Short raised standings and low mangers will help cows to lie clean. Cowshed so constructed that it is easily cleaned out (concrete floor); a gutter provided at rear of cow, which can be easily cleansed, to catch dung and urine. (2) Ample provision of clean bedding. (3) Grooming of cows. In winter when cows begin to lie in at night, all long hair round hindquarters, flanks, tail, and udder, etc., should be clipped with horse clippers. Each day, before milking, these parts should be brushed clean with a wet brush and frequent changes of water, and the loose moisture dried off with a clean cloth. Especial care in this process should be given to the udder. (4) First draws from each teat should not go into the milking pail.
Bacteria collected inside teat.	
Dirt on milker's hands. (a) Lack of personal cleanliness. (b) Handling dirty stool as he passes from cow to cow, or adjusts its position.	(a) Hands should be thoroughly washed immediately before milking (preferably before each cow). For this purpose a pail or basin, and plentiful supply of clean water, soap and a clean towel, should be provided. (b) Milking stool to be kept very clean by scrubbing regularly with soap and water.
"Wet milking."	Dry milking should be gradually introduced and insisted upon.†
Dust (from the air) getting into milk.	(1) Cowshed should be cleansed and limewashed at regular intervals. N.B.—Limewashing to a certain extent acts as a disinfectant, but its chief object is to show up collections of dirt which form dust that may blow into the milk on a windy day. (2) Employment of partially covered milking pails, thereby minimising surface of milk exposed to dust from air, or dirt falling in from cow.‡
Dirty utensils, etc. (1) Milking Pail. (2) Strainers. (3) Cooler and Milk Receiving Vessel. (4) Churns.	These should be properly constructed with seams flushed smooth with solder so that there should be no crevices in which dried milk and dirt can collect. They should be rinsed in cold water immediately after use so that film of milk may not dry on surface; then scrubbed in hot water and soda, and finally, if possible, be boiled or steamed. If not washed in cold water first, the hot water may harden collection of milk, which will act as a persistent source of contamination to all milk introduced into the pail. After cleansing they should be placed bottom upwards on a clean rack to drain. They should not be dried with a cloth as this means fresh bacteria would be introduced. Straining discs of cloth or cotton wool which can be thrown away after last milking, are to be strongly recommended. Details of cleansing, etc., as for pails; especial attention to be given to the tap. If responsibility for cleanliness of these rests with farmer, they should be treated like pails. Owing to their size, steaming must take the place of boiling.

†Many farmers do not approve of dry milking, and even if they wish to introduce this method it is found that the milkers are very averse to making the change. It should be noted, however, that in the opinion of many who have had much practical experience, dry milking is in no way detrimental to the milk-producing capabilities of the cow. Providing the milker's hands and the cow's teat are quite clean, soreness is not caused, and it is found that the teat soon develops a soft tough character which leads to easy milking. No one can deny that "wet milking" is theoretically and actually most objectionable.

‡This type of pail is objected to by many farmers on the grounds that milk is lost through unskilful aiming of the stream. It should be remembered, however, that if such pails are upset or partially upset, by a fractious cow, the loss of milk is much less than would be the case with the ordinary pail, and it is a point for the practical farmer to decide whether the milk saved in this way does not more than counter-balance that lost through bad aiming of the stream.

N.B.—In order to produce clean milk with a consistently good keeping quality, it is necessary to sterilise all dairy utensils. When using a steaming tank the supply of steam should be so adjusted that the tank is heated up to 210 deg. F., in about 20 minutes, a further 10 minutes at a temperature of 210 deg. F. will ensure that the utensils are sterile. Immediately after steaming open the door of the tank to allow the vessels to dry off, after which the door should be closed or a piece of muslin used to keep out dust and flies, etc.

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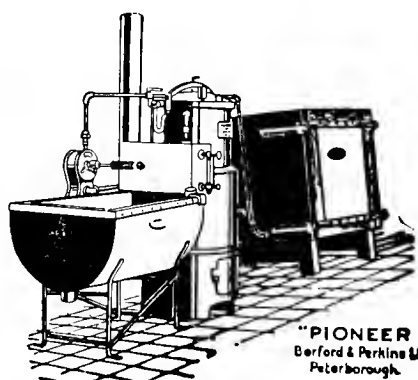
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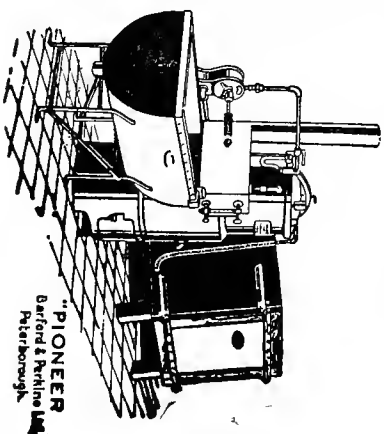
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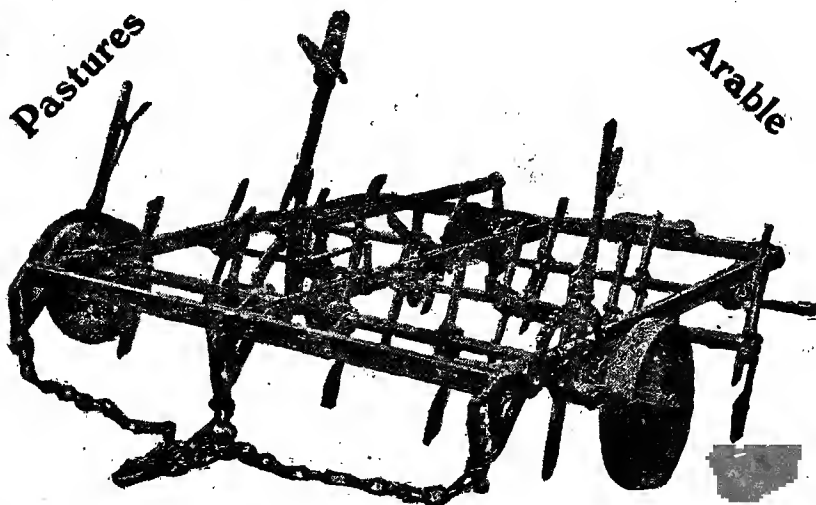
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